Rotating Electrical Troubleshooting Guide

Identify and understand the key components to the starting and charging system.

Remy®

WE START THE WORLD & KEEP IT RUNNING™

Rotating Electrical Troubleshooting Guide

Before you start

Each page contains information and instructions that are important in assisting with the repair of your starting and charging system.

Due to the electrical complexities of today's modern vehicles, it is important to determine why the unit failed. This manual will be most helpful in correctly finding the root cause of the difficulty, the first time.

At Remy, it is our goal to provide you with a product that has passed the most severe and stringent tests in the industry. To insure that the starter motor and/or alternator perform to your complete satisfaction, we have taken the necessary steps to provide you the guidelines to achieve that objective.

Our technical assistance team at Remy are ASE certified and have available the latest wiring schematics and technical information.

For Technical Assistance

1-800-854-0076

Mon - Fri: 8AM – 8PM EST

Sat: 8AM – 4:30PM EST

Remy®

WE START THE WORLD & KEEP IT RUNNING™

OEM Quality Alternators and Starters

Our vast engineering experience and manufacturing capabilities are carried over to our aftermarket products, providing the professional installer with the highest industry quality in fit, form, and function. Every unit must pass a stringent computerized load test that monitors key functions and parameters to simulate the actual demands of "real life" driving conditions.

World Class Quality and Engineering

Remy differentiates itself from aftermarket competitors through in-house engineering and global manufacturing capabilities. World-Class manufacturing processes incorporating ISO, Six-Sigma and Lean principles insure each unit is produced to the highest possible standards.

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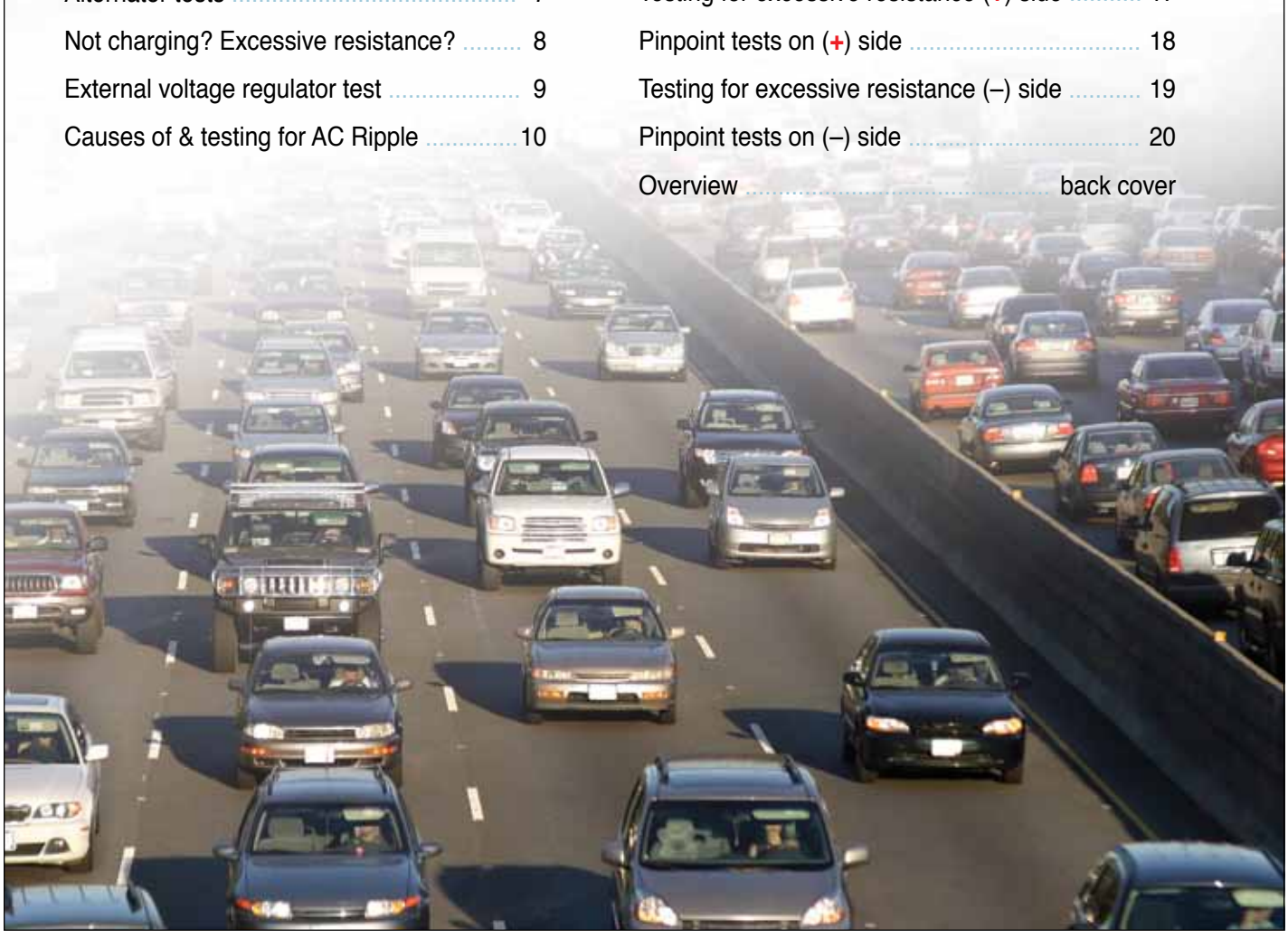


2

Belts

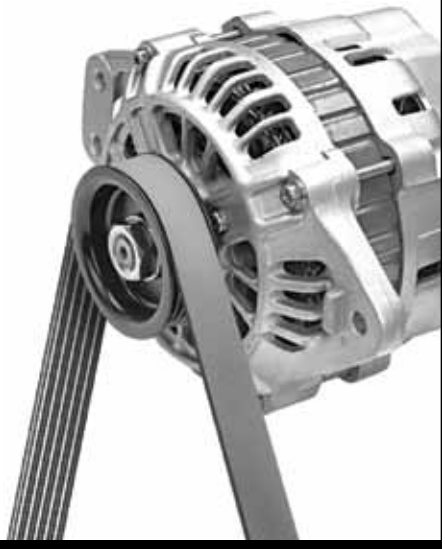
The alternator is only as good as the belt.

With the engine running, if dash indicator light stays on or flashes erratically, check the following:

1. Can pulley or fan be turned by hand due to loose or glazed belt? Belt will slip resulting in low output; dash light may stay on or flicker.
2. Is the belt cracked or contaminated with oil, ATF, coolant, etc?
3. Check for excessive noise from alternator. Could be a loose, worn belt, or pulleys not aligned.

Are the belts:

- Glazed/shiny?
- Oil soaked?
- Correct tension?
- Cracked?
- Misaligned?
- Squealing?

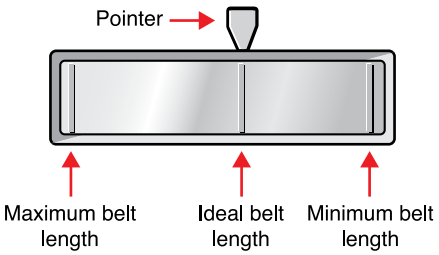


Belt Tensioner

Automatic belt tensioners and idler pulleys do fail.

Belt tensioner:
Is the spring tension too tight? Too loose?

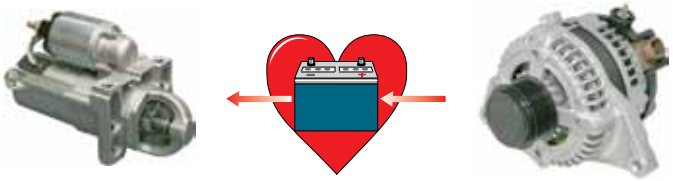
Belt stretched?
Check gauge on tensioner.



Battery

The battery is the heart of the system.

Starter motor "draws" power from the battery.



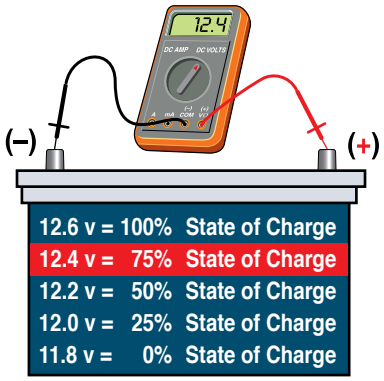
Alternator "generates" electric current to replace power lost and supply vehicle electrical system.

Battery Testing

There are two key tests to determine condition of battery.

1 State of charge test

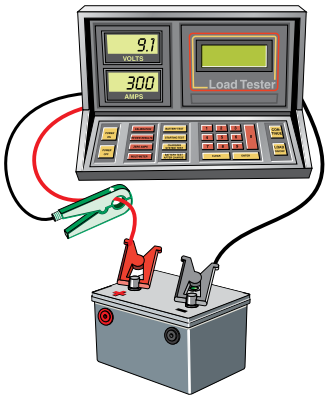
The battery voltage must be at least 12.4 volts before load test.



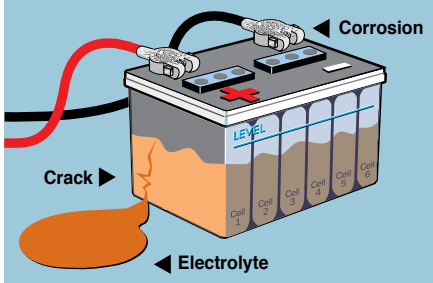
2 Load test

Load test simulates the electrical demands placed on the battery.

If load tester is not available, have your alternator/battery supplier test the battery.



Battery condition:



1. Plates covered with water?
3. Top of battery clean?
2. Is battery secure in tray?
4. Correct size for vehicle?

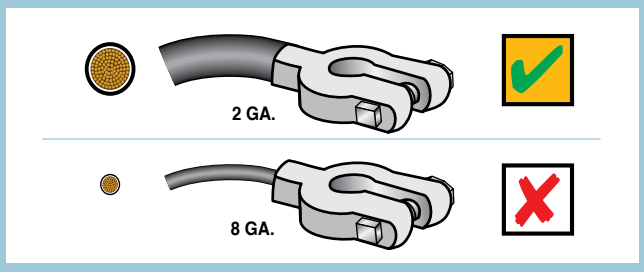
Battery Cables

Cables connect your alternator and starter to the battery.

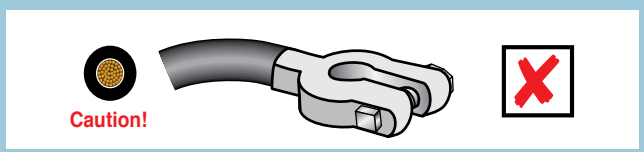
Carefully inspect cables for:

1. Signs of cracked insulation.
2. Too long or short. While attempting to crank engine, do battery cables feel warm to the touch? If warm to the touch, cable gauge may be too small.

Lower gauge number allows for greater amperage flow. Which cable will carry more power to the battery?



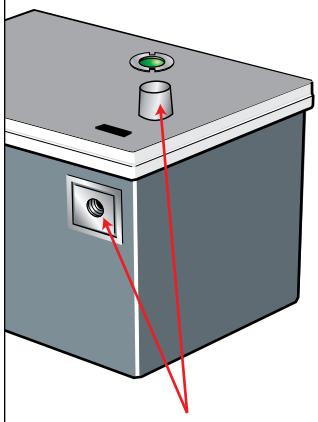
There are some cables sold with thick insulation and very little copper. Look for gauge size printed on cable insulation.



Connections

Critically important.

Often overlooked, battery terminal ends and all cable connections are extremely vital



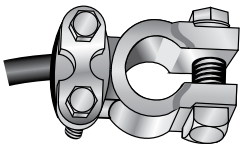
Clean connections?

Temporary ends can dramatically shorten life of an alternator or starter. How?

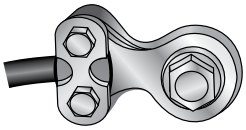
Bare strands of copper wire under steel plates, bolted to lead terminal ends, and exposed to humidity equal corrosion.

- Apply correct terminal protection product.
- Far better to use molded/crimped style terminals.
- It is important that NO bare copper wire is exposed to the environment.

Temporary ends



Top post



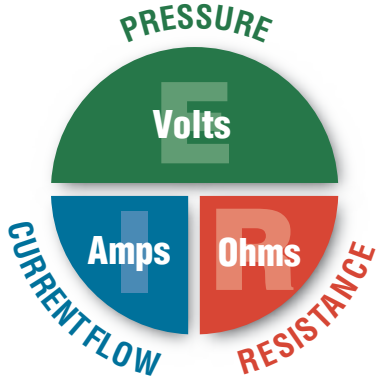
Side terminal

Excessive Resistance

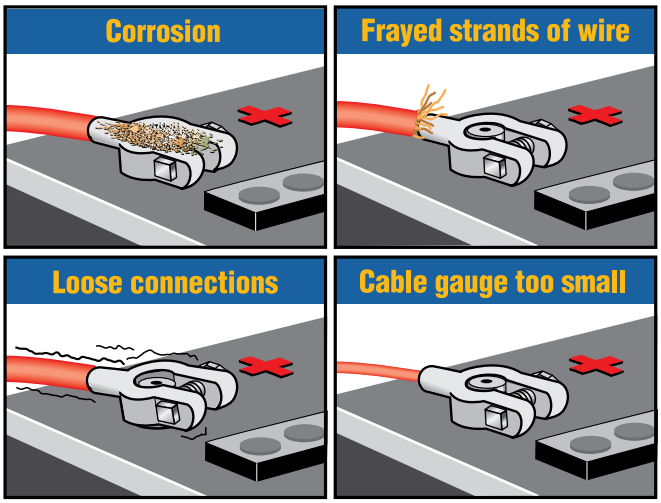
The starter and alternator are only as good as the connections.

Until you completely eliminate excessive resistance, your starter and alternator will not function properly.

All connections should be metal to metal, clean and tight.



4 possibilities for resistance



Alternators: Where to Begin

Symptoms	Possible Cause	Action Needed
No output from alternator **Battery condition good** **Dashboard indicator light illuminates when key on, engine off.**	• Drive belt broken or loose • No voltage signal to field through regulator plug • Voltage not present at alternator B+ terminal	• Replace or tighten belt. • Check regulator plug for corrosion or melting. Replace pigtail if necessary. • Check fusible links and wire going to B+ terminal.
Dash board charging indicator does not light while key on, engine off.	• Blown fuse or fusible link • Light bulb burned out	• Check and replace fuses as needed. • Replace charging indicator light bulb.
Low voltage output from alternator	• Corroded or loose connections • Drive belt slipping • Belt tensioner weak	• Clean and tighten connections and perform voltage drop test. • Use test gauge on belt to determine if replacement is needed. • Check tensioner alignment marks for weakness.
Lights dim at idle while all accessories are off.	• Cables corroded • Improper body ground • Drive belt slipping or tensioner is weak • Improper engine rpm's at idle • Weak or defective battery	• Clean and tighten connections and perform volt drop test. • Clean and tighten body ground. • Check belt and tensioner for excessive wear. • Refer to manufacturer's specifications and repair if needed. • Test battery and replace as needed.

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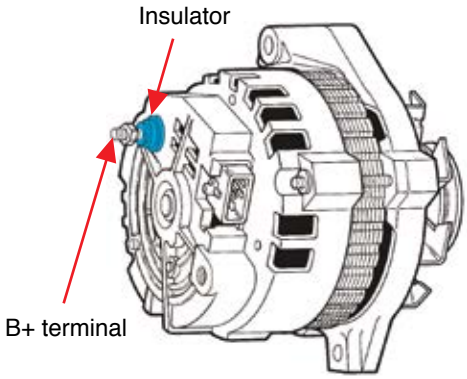
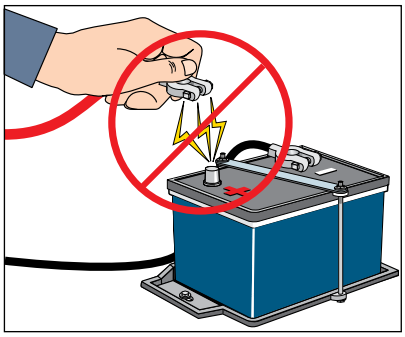
B+ Terminal

Is battery voltage available at B+ terminal?



1. Connection must be clean and tight at B+ terminal.
2. Do not over tighten and crack insulator.
3. Be careful not to strip threads.
4. Does wire from B+ terminal bolt connect to a fusible link at starter solenoid? If so, make sure the fusible link is clean and tight.
5. All brackets to alternator connections should be clean metal-to-metal.

   Note: Before removing alternator, make sure battery (–) cable is disconnected.



Removing either battery cable with engine running will create a damaging voltage spike.

This was never a valid test for an alternator.

Voltage spikes and arcing are poison to the electrical system.

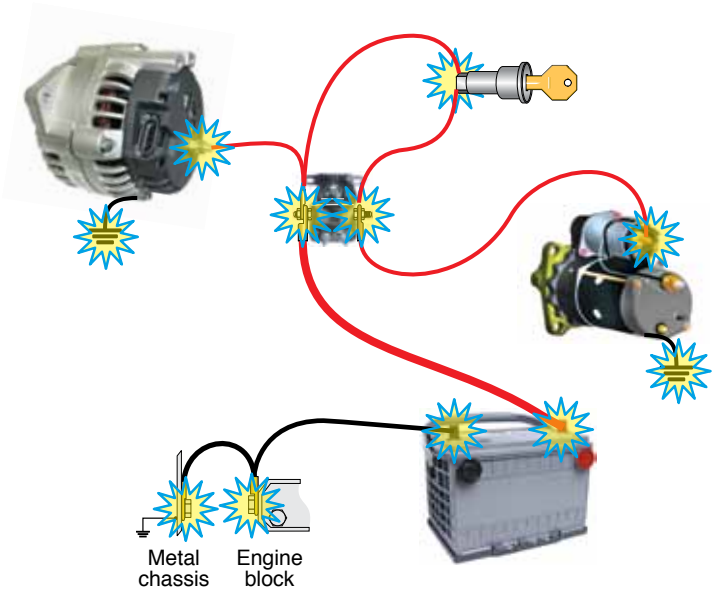
Alternator and system management computers may be damaged and or destroyed.

OE vs Aftermarket

Why doesn't the replacement alternator last as long as the OE unit?

Answer:
Poor connections and excessive voltage drop

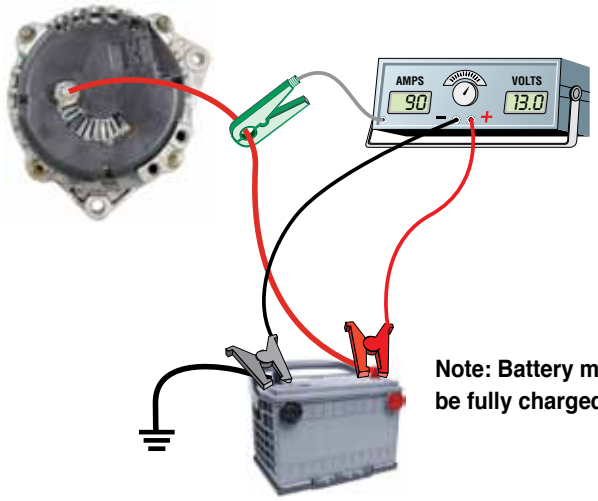
Clean and tight connections insure electrical system functions as designed.



Amperage Test

Testing the alternator for AMP capacity.

1. Place AMP inductive clamp on heavy gauge wire(s) coming from back half of alternator.
2. With engine at normal operating temp, and at high RPM's, load engine down by turning up the load on the carbon pile tester amperage reading.
3. The unit is good if AMP output is within 80–100% rated output.
4. If AMP reading is low, it could be a bad alternator or excessive resistance may be in the charging circuit.



Note: Battery must be fully charged

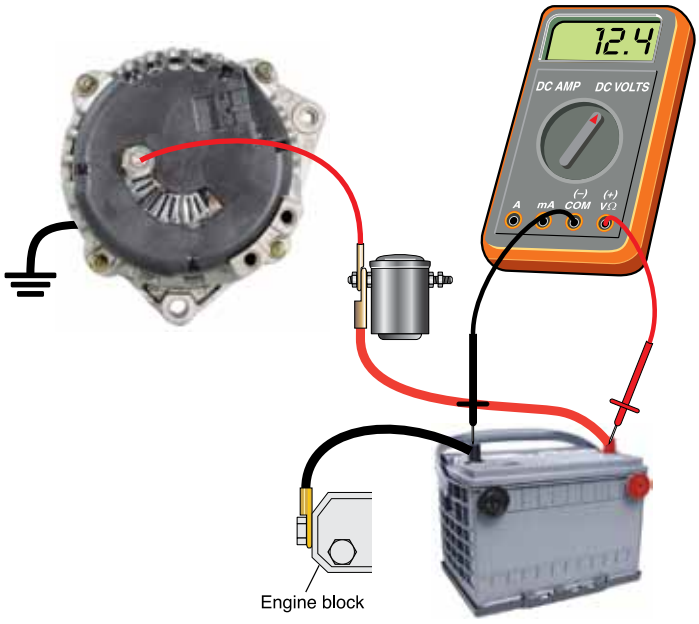
Alternator Tests

Voltage test.

This procedure does not apply to computer controlled charging systems.

1. With voltmeter connected to battery, key and engine off, record "base" voltage reading: _____ volts.

   Note: Battery should have minimum of 12.4 volts.
2. Start engine and bring to normal operating temperature.
3. With engine at 1500 to 2000 RPM, turn on all electrical loads (lights, blower fan, A/C, etc.) record volts: _____volts.
4. Charging voltage should be at least 0.5 volt above base voltage reading. If not, excessive resistance could be present.



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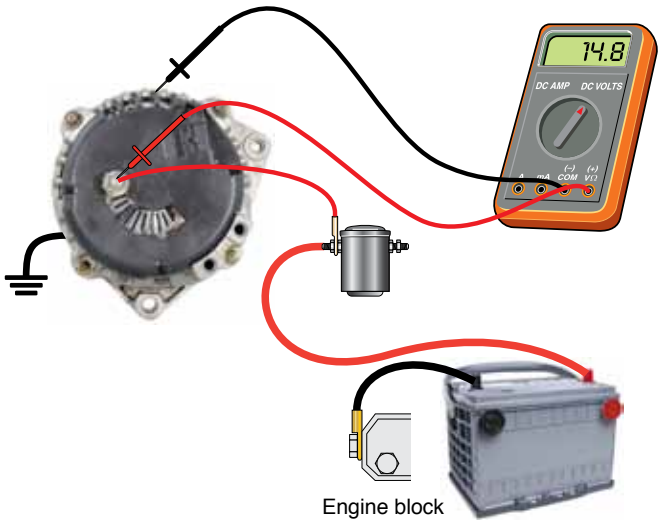
Voltage at the Alternator



Check charging voltage at alternator (illustration to left) and then again at battery (below test). This test will determine if there is a problem between the alternator and battery.

With engine running, 1500 to 2000 rpm, loads on:

1. Measure charging voltage at alternator, and record: _____volts.

2. Measure open circuit voltage at battery, and record: _____volts.

3. If the difference is greater than 1 volt, there is a problem.

Voltage

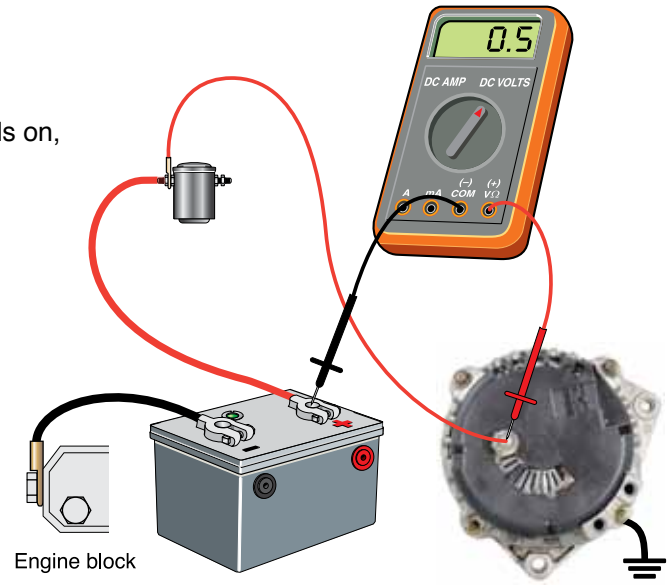
Not charging?

Looking for excessive resistance on the (+) side:

- Voltmeter (+) test lead to alternator B+ terminal
- Voltmeter (–) test lead to battery (+) post
- Set voltmeter on lowest DC volt scale
- With engine running at 1500 to 2000 rpm, all loads on, measure and record voltage drop_____.

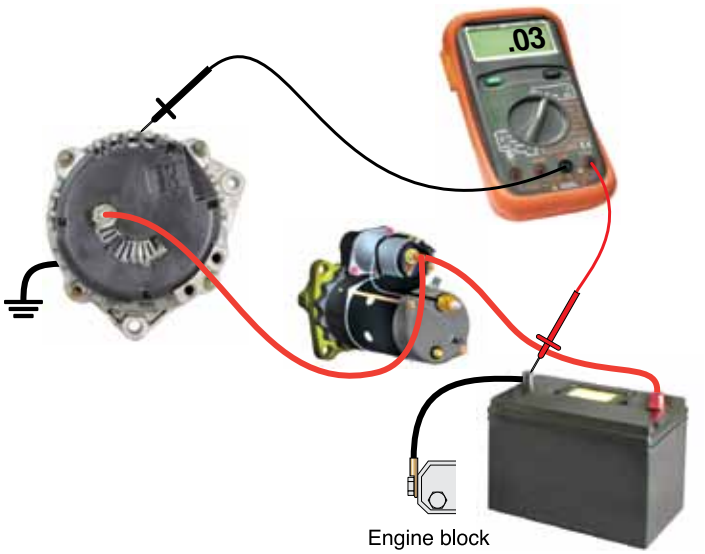
Note: Should not exceed 0.5 volt drop. If voltage drop exceeds 0.5 volt, check for:

- Corrosion
- Frayed strands of wire
- Loose connections
- Battery cable gauge too small



Still Not Charging?

There is resistance in the charging circuit somewhere.



Couldn't find the excessive resistance on the (+) side? Let's check the (–) side:

- Voltmeter (+) test lead to battery (–) post
- Voltmeter (–) test lead to alternator case
- Set voltmeter on lowest DC volt scale.
- With engine running at 1500 to 2000 rpm, all loads on, measure and record voltage drop:_____.

Note: Should not exceed 0.3 volt drop

If voltage drop exceeds 0.3 volt, check for:

- Corrosion
- Battery cable gauge too small
- Loose connections
- Frayed strands of wire

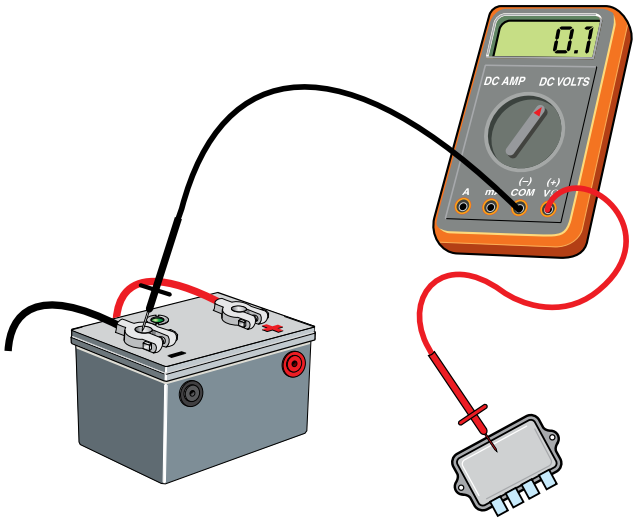
External Voltage Regulator

All alternators with external voltage regulators.

Regulator must have a good ground (⏚) in order for alternator to function.

To determine if external voltage regulator is properly grounded, follow these simple steps:

1. Engine running, no loads on
2. DVOM (+) lead to the regulator metal housing
3. DVOM (–) lead to battery (–) post
4. Set DVOM on lowest DC volt scale.
5. If reading is 0.1 volt (or 100mv) DC or above, the regulator does not have a good ground.
6. Clean and retest for a good ground.



External voltage regulator

AC Ripple Voltage

What is AC voltage ripple and how does it cause problems?

AC Voltage ripple is alternating current riding on top of DC current

- Causes poor voltage source to modules: ABS, ECU, PCM, etc.
- Modules need quality DC voltage source to make accurate decisions, on the (+) side and (–) side.
- Changing amplitude of AC voltage ripple on top of linear DC voltage can cause module to lose its place in the engine run program.
- This results in:
  - Erratic spark timing
  - Missing fuel injector pulses
  - Significant driveability problems

Corrosion acts like a semi-conductor causing DC voltage to fluctuate

Excessive AC ripple caused by:

- Alternator: bad diodes or stator
- Corrosion at the battery or any connection
- Sulfated battery

AC Ripple Tests

What is the most accurate tester to measure for AC ripple?

Usage of a voltmeter, due to the slow refresh rate, is not an accurate test.

Many have used an “Averaging” voltmeter. Some have graduated to an “RMS” voltmeter.

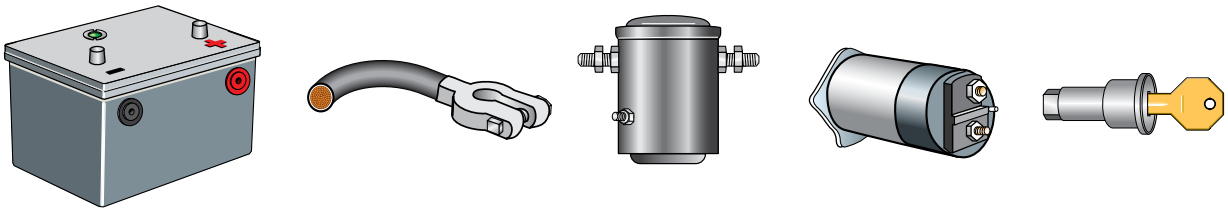
However, due to changes in alternator design technology, such as amount of current produced, rotor shaft RPM, stator windings, it is far more accurate to use a Lab Scope.

A scope will provide an actual “footprint” of the AC Ripple, not just a voltage number.

Lab Scope

Cranking Circuit

The following components have a profound effect on the starter and its ability to crank the engine:

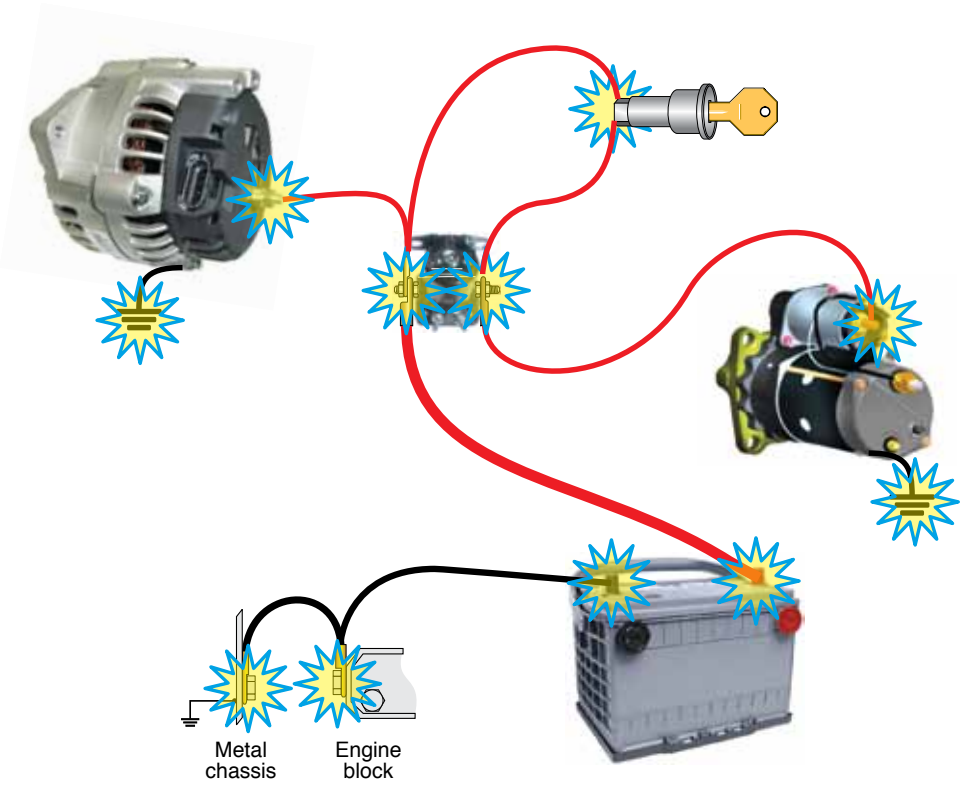


- **Battery**
- **Battery cables**
- **Relay/solenoid**
- **Neutral safety switch**
- **Alarm system**
- **Ignition switch**

Connections

Why doesn't the aftermarket starter motor last as long as OE?

Answer: Poor connections and excessive voltage drop



Potential Problems

Note: the starter motor is only as good as each one of these connections.

Starters: Where to Begin

Symptoms	Possible Cause	Action Needed
Engine will not crank.	• Dead battery • Defective fusible link • Loose connections • Defective ignition switch • Defective solenoid/mag switch, relay, neutral start switch or clutch switch • Mechanical problem in engine • Problem in vehicle anti-theft system	• Check battery state-of-charge. • Replace fusible link. • Clean and tighten connections. • Check switch operation, replace as needed. • Check and replace as needed. • Check engine. • Check service manual for system tests.
Engine cranks too slow.	• Weak battery • Loose or corroded connections • Defective starter motor • Mechanical problem with engine	• Check battery state of charge. • Clean and tighten connections. • Test starter. • Diagnose engine problem and repair.
Starter keeps running.	• Damaged pinion or ring gear • Defective starter or magnetic switch • Defective ignition switch or control circuit	• Check gears for wear or damage. • Test starter, and Magnetic switch. • Check switch and circuit components.
Starter spins, but engine will not crank.	• Defective drive clutch • Defective starting motor	• Rotate pinion by hand, it should not go both ways. • Test motor and verify drive extension.
Starter does not engage or disengage properly.	• Defective solenoid/mag switch • Damaged or worn pinion gear or ring gear	• Bench test starter, if passes check external switches / control circuit. • Check teeth on both drive and ring gear.

Starter Shims

Noisy, grinding starter “To shim or not to shim”.

In order for starter to operate efficiently and quietly, shimming may be required, even if shims were not used on original installation.

On some applications, you will have to either add shim(s) or remove shim(s) to achieve correct “gap” (clearance).

Proper clearance between starter drive pinion gear and flywheel ring gear is critical for correct operation of starter (See Fig. 1).

To achieve correct gap between ring gear and starter drive, usage of one or more shims may be required on certain GM engines (See Fig. 2).

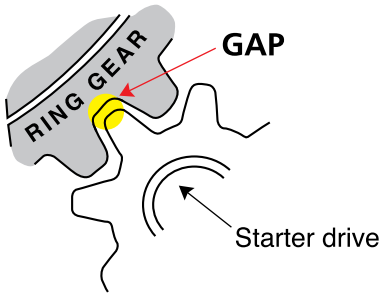


Fig. 1

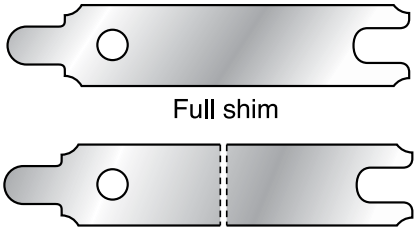


Fig. 2

Does your starter motor require a shim(s)?

Use your ears to listen for problem sounds.

Do you hear a high pitched whine or clanging sound while cranking, BEFORE engine starts?

Problem: excessive clearance

Starter must be shimmed closer (into) ring gear to reduce gap (clearance).

Remove any existing shims.

Start with one .015” shim cut in half on outboard bolt only (the bolt on outside of starter motor away from engine) See Fig. 3.

This will move starter closer into the ring gear.

Gap too loose?

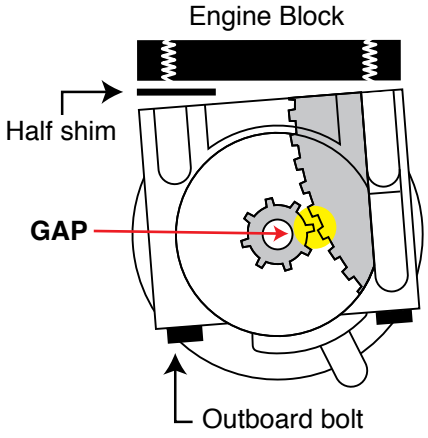


Fig. 3

Starter Shims

Does your starter motor require a shim(s)?

Use your ears to listen for problem sounds.

Do you hear a high pitched whine **after** engine starts, as key is being released?

Problem: not enough clearance.

Starter must be shimmed away from ring gear to increase gap (clearance).

Install one .015” shim across **both bolt holes** to increase gap (See Fig. 4)

OR

Install one .015” shim cut in half or a substitute shim on inboard bolt only; the bolt on inside of starter motor closest to engine (See Fig. 5).

Usage of one shim on inboard bolt only, will provide greater clearance.

Note: Do not use more than 3 shims on either side.

Gap too tight?

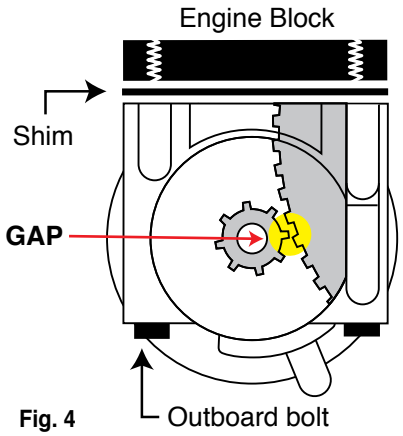


Fig. 4

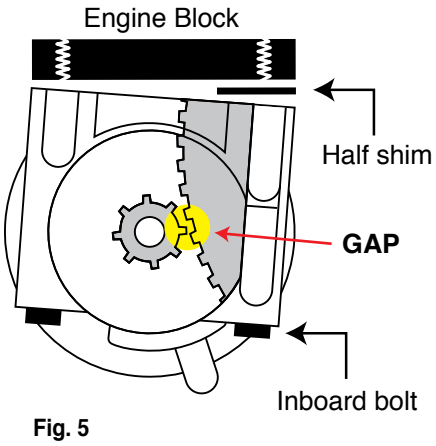


Fig. 5

When installing replacement starter motor

DO NOT use an impact gun or breaker bar to tighten bolts! Nose cones are made of aluminum and are very easy to distort or crack by over tightening.

- Always reinstall any existing heat shields and rear support brackets.
- Make sure all connections at solenoid are clean and tight.
- Add or remove shims one at a time to avoid damage.

Providing the proper gap will award you with a quiet starter and a longer life

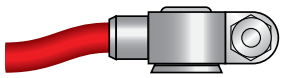
Cables and Connections

Too hot to handle?

While cranking, if either battery cable feels hot, gauge of cable may be too small or too long or possibly a short within the starter. When replacing battery cables, always use shortest, heaviest gauge cables possible.

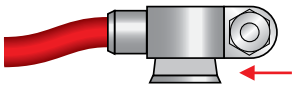
Check connections

Right



Terminal end is pressed down completely over battery post.

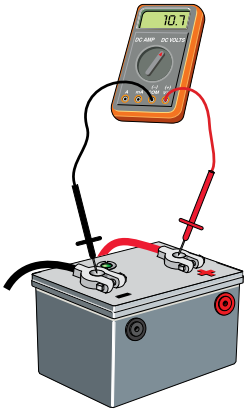
Wrong



Terminal end is not properly seated.

Cranking Voltage

At two locations?



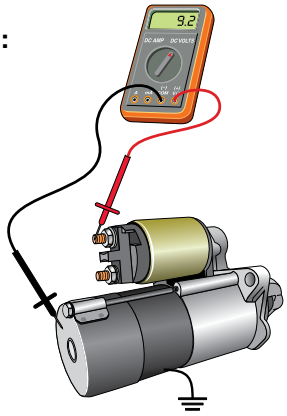
While Cranking:

10.7 volts

– 9.2 volts

1.5 volts

PROBLEM!



If the difference is greater than 1 volt, excessive resistance is present.

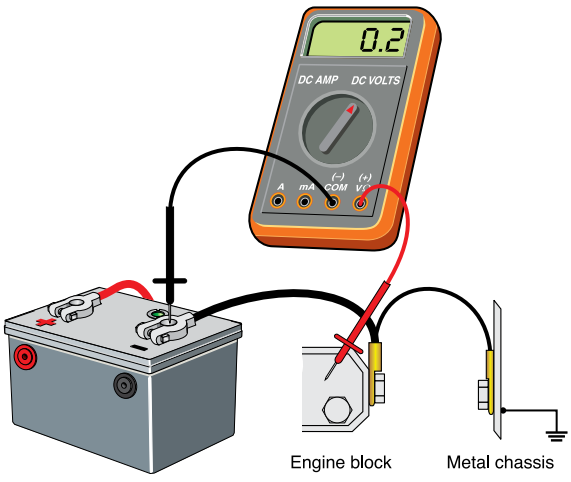
Excessive resistance could be on the + or – side or the side of the cranking circuit.

To prevent engine from starting, some vehicles may not start with (WOT) See manufacturer's service manual.

Good Ground?

The starter motor is grounded to engine block. Engine must have a good ground through the battery cable back to battery (–) terminal in order to crank.

- To prevent engine from starting, some vehicles may not start with (WOT). See manufacturer's service manual
- With voltmeter test leads as shown, measure and record voltage while cranking: _____ volt.
- If voltage exceeds 0.2 volt, there is a poor ground in (–) cable or connections.



Amp Draw Specs

"Approximate" amp draw specifications.

Engine Size		Amp Draw
Cubic Inches	Liters	
100 to 200	1.6 to 3.2	100 to 200
200 to 350	3.2 to 5.6	125 to 250
350 to 500	5.6 to 8.0	150 to 300

There is no fixed amperage draw for every engine Why?

- Engine size
- Compression
- Carbon buildup
- High torque, low torque, gear reduction, etc.
- Weight (viscosity) of oil
- Mechanical condition of engine
- Design of starter motor

All have an impact on amperage draw.

Analyze Cranking Voltage & Amperage

1

Problem: high mechanical resistance, resulting in high amp draw.

Amps High

Volts Low

Possible causes:

- Carbon build up on top of pistons
- Wrong weight oil
- Cable that is shorted to ground
- Bad starter
- Binding engine

2

Problem: high electrical resistance, resulting in low amp draw.

Amps Low

Volts Normal

Possible causes:

- Loose connections
- Frayed cables, etc.
- Corrosion
- Cable gauge too small resulting in high resistance

3

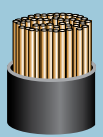
Problem:

A weak or undersized battery resulting in:

- Low cranking voltage
- Slower spinning armature causing starter to draw excessive amps
- Destroyed starter

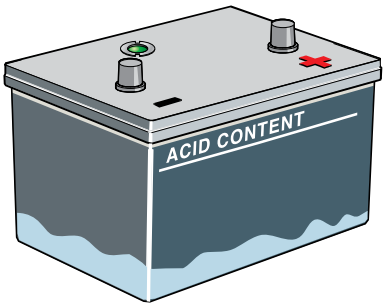
Amps High

Volts Low

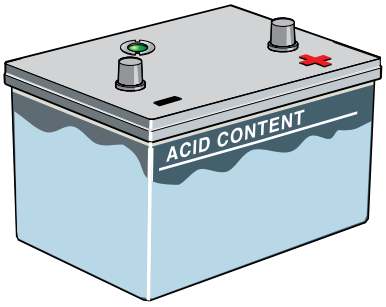


Weak Battery?

A weak or undersized battery will cause high amp draw.



Weak battery



Strong battery

Weak battery

- Voltage drops to 9.5 volts while cranking
- Example: starter motor needs 2095 watts
- Volts x AMPS = watts
- How many amps will this starter motor now need in order to crank?
- 2095 watts ÷ 9.5 volts = 220 AMPS

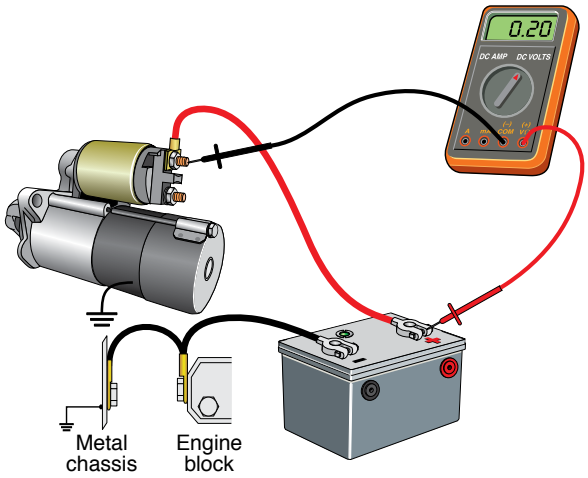
Strong battery

- Voltage drops to 11.2 volts while cranking
- Example: starter motor needs 2095 watts
- How many AMPS will this starter motor now need in order to crank?
- 2095 watts ÷ 11.2 volts = 187 AMPS

Testing (+) Side

Testing for excessive resistance on the (+) side.

1. Must have fully charged battery
2. To prevent engine from starting, some vehicles may not start with (WOT). See manufacturer's service manual.
3. Set DVOM on lowest volt scale.
4. DVOM (+) lead to battery (+) post
5. DVOM (–) lead to battery terminal stud on starter
6. While cranking engine over, record _____voltage drop (excessive resistance).
7. If voltage drop exceeds 0.5 volt, clean all connections between battery & starter.

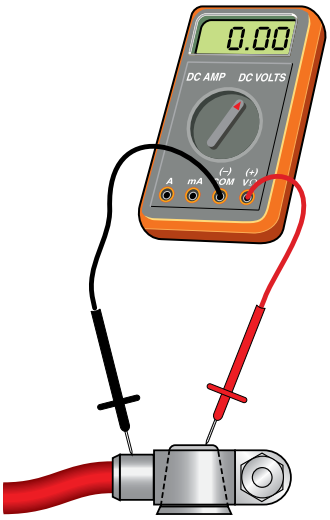


Positive Side (+)

Starter motor pinpoint tests on positive side.

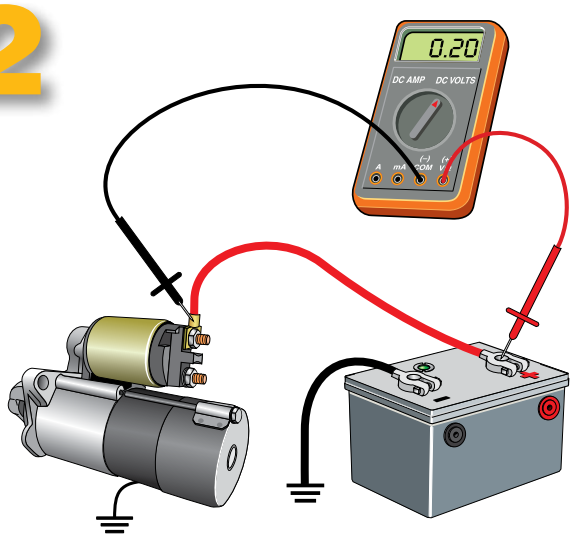
1. Must have fully charged battery
2. To prevent engine from starting, some vehicles may not start with (WOT). See manufacturer's service manual.
3. Set DVOM on 2 volt scale or lowest volt scale.
4. Engine at normal operating temp
5. The following pinpoint tests will show you exactly where the excessive voltage drop is located.

1



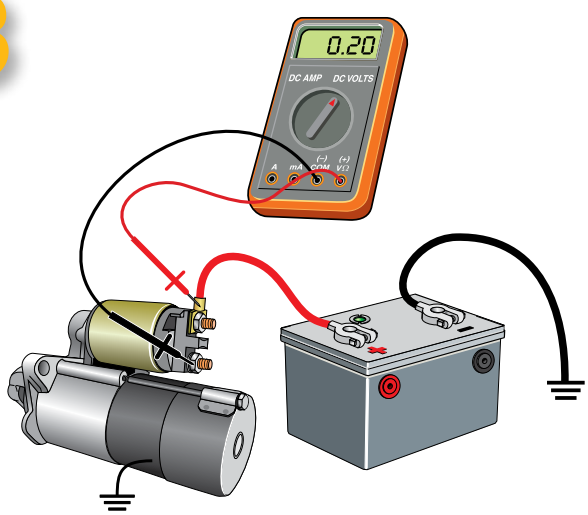
_____**Maximum v/drop 0.00**

2



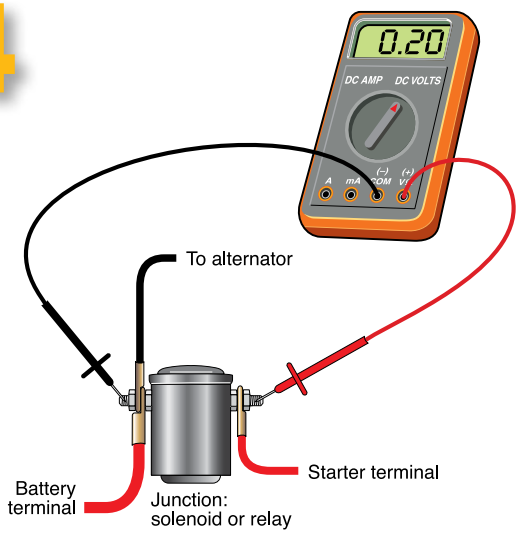
_____**Maximum v/drop 0.20**

3



_____**Maximum v/drop 0.20**

4

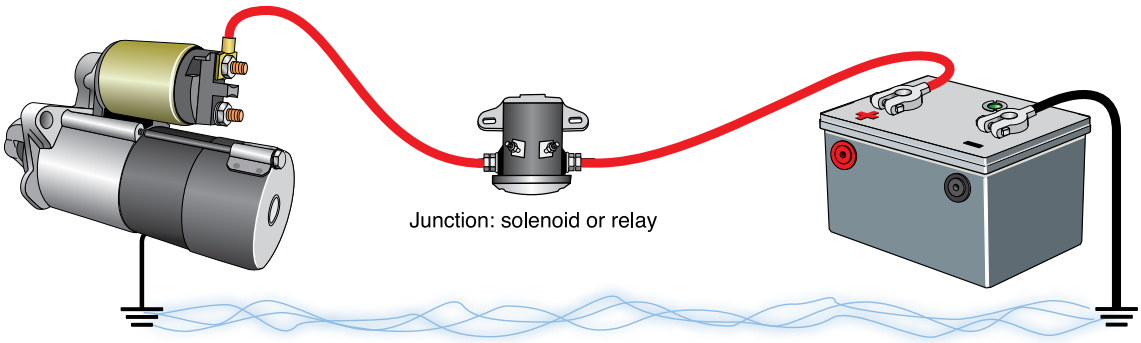


_____**Maximum v/drop 0.20**

Amperage

Amperage must flow in a complete circuit.

Why test for excessive resistance on the (–) side?
Ohm's Law states: Amperage out, amperage in



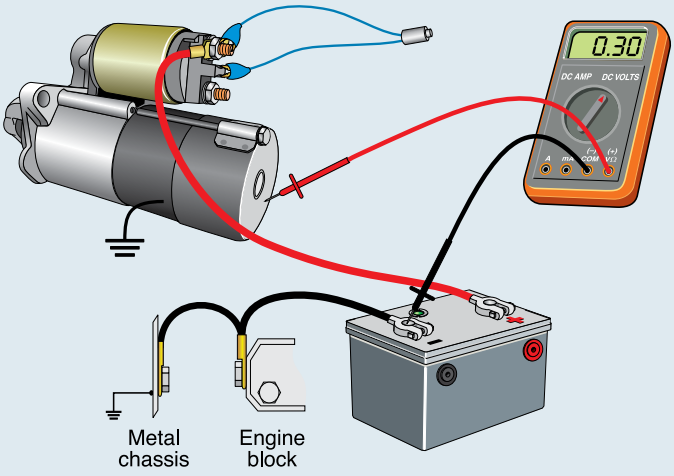
All amps that reach the starter motor, must return to battery (–) post.
Excessive resistance could be anywhere within the (–) path.

The starter motor is grounded through the nose housing to engine block.
This connection must be clean and tight.

Testing (–) Side

Testing for excessive resistance on the (–) side.

1. Must have fully charged battery
2. To prevent engine from starting, some vehicles may not start with (WOT).
   See manufacturer's service manual.
3. Set DVOM on lowest volt scale.
4. DVOM (+) lead to clean metal spot on starter
5. DVOM (–) lead to battery (–) terminal
6. While cranking engine over, record _____voltage drop (excessive resistance).
7. If voltage drop exceeds 0.3 volt, clean all connections between battery and starter.

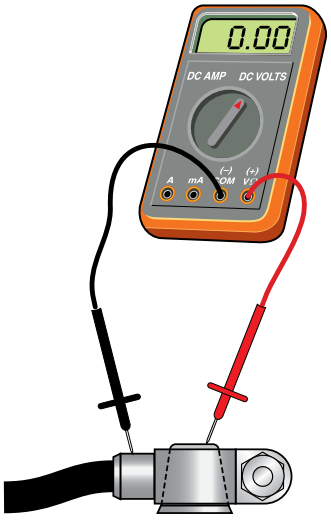


Negative Side (–)

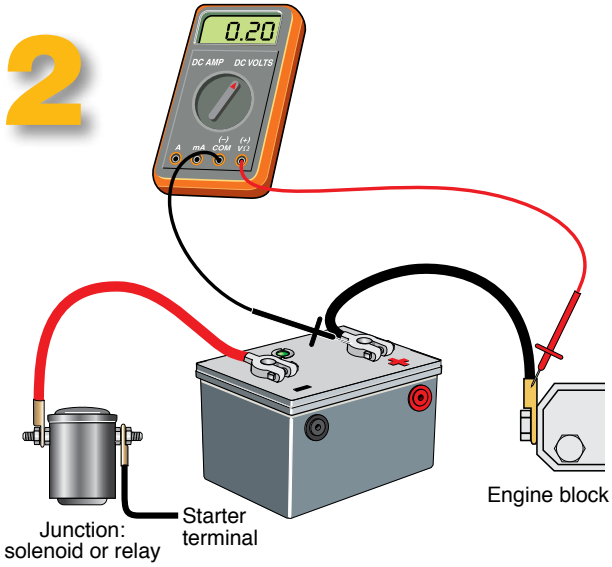
Starter motor pinpoint tests on negative side.

1. Must have fully charged battery.
2. To prevent engine from starting, some vehicles may not start with (WOT). See manufacturer's service manual.
3. Set DVOM on 2 volt scale or lowest volt scale.
4. Engine at normal operating temp.
5. The following pinpoint tests will show you exactly where the excessive voltage drop is located.

1

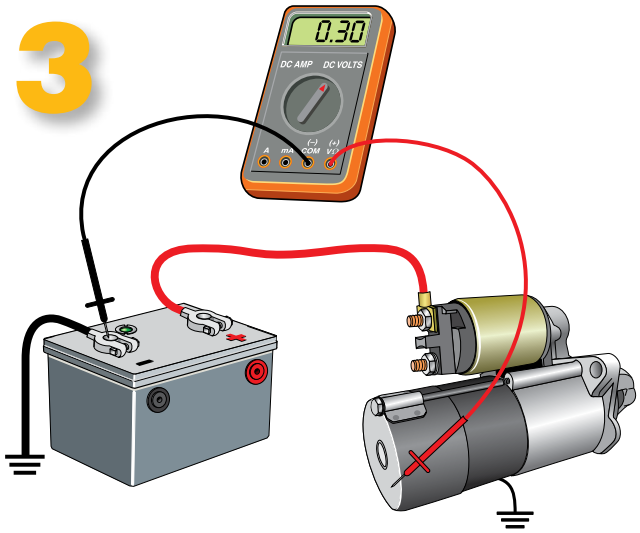


2



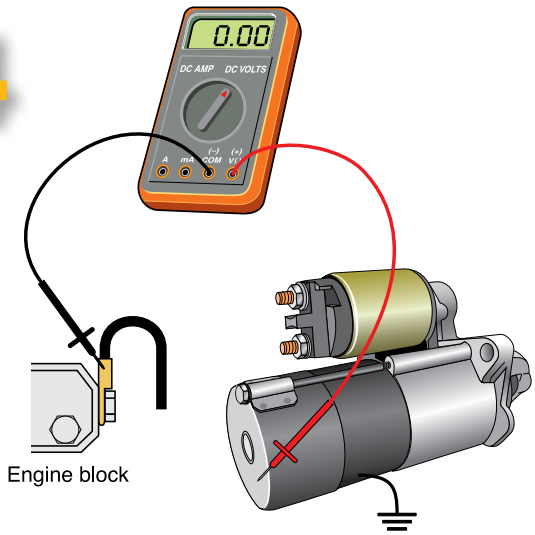
_____**Maximum v/drop 0.20**

3



_____**Maximum v/drop 0.30**

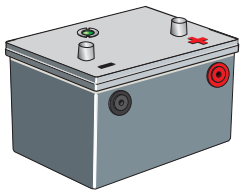
4



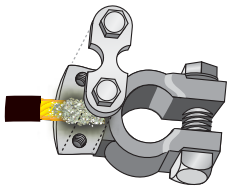
_____**Maximum v/drop 0.00**

Notes

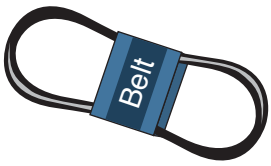
Charging & Starting System Testing Overview



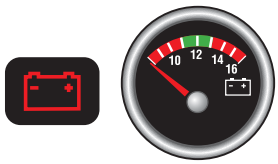
Test the battery: right group size, state of charge, load test.



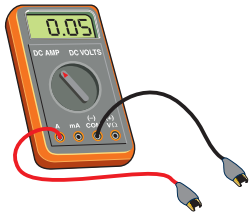
Check connections and cables.



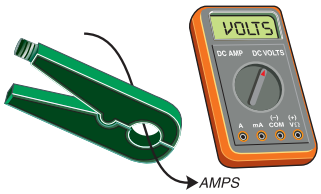
Check drive belt condition, tension, automatic belt tensioner.



Check operation of dash light indicator or dash voltmeter.

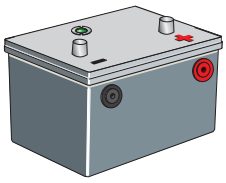


Check for excessive parasitic draw.



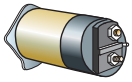
Check charging voltage and amp output.

Key components to be tested before removing the starter motor

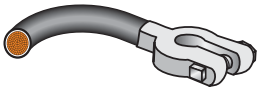


Battery and connections

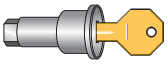
Relay



Solenoid



Battery cables



Switches

Need Assistance?

Tech Support: 800-854-0076

Email: tcs@remyinc.com

Monday thru Friday 8AM – 8PM EST

Saturday 8AM – 4:30PM EST

Remy International, Inc.
600 Corporation Drive
Pendleton, IN 46064 USA

remyinc.com

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